Electromagnetic Emission

F C C M E A S U R E M E N T R E P O R T

CERTIFICATION OF COMPLIANCE

FCC Part 15 Certification Measurement

PRODUCT	:	ReFlex Telemetry Device
MODEL/Serial No.	:	M1503 / Proto type
MULTIPLE MODEL	:	-
BRAND NAME	:	HuneTec
FCC ID	:	RNGM1503RFX
APPLICANT	:	Hunetec Co., Ltd RM 612, Starwood Plaza, 5439-1 Sangdaewon-Dong, Jungwon-Gu, Sungnam-City, Kyunggi-Do, Korea (ZIP CODE: 462-120) Attn.: David Kim
MANUFACTURER	:	Hunetec Co., Ltd RM 612, Starwood Plaza, 5439-1 Sangdaewon-Dong, Jungwon-Gu, Sungnam-City, Kyunggi-Do, Korea (ZIP CODE: 462-120)
TYPE OF MODULATION	:	4level FSK
FREQUENCY RANGE	:	24D: 901.0 MHz to 902.0 MHz 90: 896.0 MHz ~ 901.0 MHz
AIR DATE RATE	:	800 bps to 9 600 bps
ANTENNA TYPE	:	0.75 W Into Antenna
RULE PART(S)	:	FCC Part 15 & 24D & 90
FCC PROCEDURE	:	ANSI C63.4-2009 / TIA-603-C-2004
TEST REPORT No.	:	ET110718.01
DATES OF TEST	:	June 13, 2011 to July 07, 2011
REPORT ISSUE DATE	:	July 18, 2011
TEST LABORATORY	:	ETL Inc. (FCC Designation Number : KR0022)

The ReFlex Telemetry Device, Model M1503 has been tested in accordance with the measurement procedures specified in ANSI C63.4-2009 at the ETL Test Laboratory and has been shown to be complied with the electromagnetic radiated emission limits specified in FCC Rule Part15 & 24D & 90.
I attest to the accuracy of data. All measurement herein was performed by me or was made under my supervision and is correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.
The results of testing in this report apply to the product/system which was tested only. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Prepared by:
Jeong Hwan, Pyo (Test Engineer)
July 18, 2011

Reviewed by:
Yo Han, Park (Chief Engineer)
July 18, 2011

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#371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea
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FCC MEASUREMENT REPORT

Scope – *Measurement and determination of electromagnetic emission (EME) of radio frequency devices including intentional radiators and/or unintentional radiators for compliance with the technical rules and regulations of the U.S Federal Communications Commission(FCC)*

General Information

Applicant Name	**: Hunetec Co., Ltd**
Address	**: RM 612, Starwood Plaza, 5439-1 Sangdaewon-Dong, Jungwon-Gu, Sungnam-City, Kyunggi-Do, Korea (ZIP CODE: 462-120)**
Attention	**: David Kim**

- **EUT Type** : ReFlex Telemetry Device
- **Model Number** : M1503
- **S/N** : Proto type
- **Freq. Range** : 24D: 901.0 MHz to 902.0 MHz
  90: 896.0 MHz to 901.0 MHz
- **Modulation Technique** : 4level FSK
- **Air Data Rate** : 800 bps to 9 600 bps
- **Antenna Type** : 0.75 W Into Antenna
- **FCC Rule Part(s)** : FCC Part 15 & 24D & 90
- **Test Procedure** : ANSI C63.4-2009 / TIA-603-C-2004
- **Place of Tests** : ETL Inc. Testing Lab.
  Radiated Emission test;
  #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

  Conducted Emission test;
  ETL Inc. Testing Lab.
  371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea

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1. INTRODUCTION

The measurement test for radiated and conducted emission test was conducted at the ETL Inc. The site is constructed in conformance with the requirements of the ANSI C63.4-2009 and CISPR Publication 16. The ETL has site descriptions on file with the FCC for 3 m and 10 m site configurations. Detailed description of test facility was found to be in compliance with FCC Rules according to the ANSI C63.4-2009 and registered to the Federal Communications Commission (FCC Designation Number : KR0022).

The measurement procedure described in American National Standard for Method of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2009) was used in determining radiated and conducted emissions from the Hunetec Co., Ltd Model: M1503

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2. PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the ReFlex Telemetry Device (model: M1503). (FCC ID: RNGM1503RFX). M1503 are Small Size and Light Weight for Portability, microcomputer-controlled frequency modulated transceivers.

Each M1503 has a AMPIRETM Liquid Crystal Display (LCD), and is powered by a BYDTM Li-Polymer battery.

The receiver operates in the 929 MHz ~ 932 MHz, 935 MHz ~ 942 MHz range; the transmitter operates in the 896 MHz ~ 902 MHz range.

2.2 General Specification

- General Specification

Item	Specification
Transmitter	
Frequency Range	896 MHz ~ 902 MHz
Channel Spacing	12.5 kHz/10 kHz
Bit Rate	800 bps ~ 9 600 bps
Signaling Modulation	4Level FSK
Frequency Deviation	800 Hz and 2 400 Hz
Frequency Accuracy	-2.5 ppm < X < 2.5 ppm
Frequency Stability	-1.0 ppm < X < 1.0 ppm
Output Power	0.75 W into Antenna
ERP	0.2 W minimum over 8 positions
Spurious Emission	< -50 dB
Occupied Bandwidth	8.5 kHz
Receiver	
Frequency	929 MHz ~ 932 MHz, 935 MHz ~ 942 MHz
Channel Spacing	12.5 kHz/10 kHz
Bit Rate	1 600 bps ~ 9 600 bps
Signaling Modulation	2 or 4 Level FSK
Frequency Deviation	800 Hz and 2 400 Hz
Receiver Sensitivity	14 μV/m at Uncabled > -116 dBm at Cabled
Frequency Accuracy	1 ppm
Adjacent Channel Rejection	> 50 dB at Channel Frequency ± 25 kHz
Co-Channel Rejection	< -12 dB at Channel Frequency ± 3 kHz
Spurious Response Rejection	> 50 dB at Channel Frequency ± 50 kHz
Image Rejection	> 40 dB at Channel Frequency ± 2IF
Inter-Modulation Distortion Rejection	> 50 dB at Channel Frequency ± 50 kHz, ± 25 kHz
Simulcast Delay Spread Tolerance	Receive ratio > 96 % at Delay 60 μs Receive ratio > 90 % at Delay 80 μs Receive ratio > 96 % at Delay 100 μs

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3. DESCRIPTION OF TESTS

3.1 Conducted Emission Measurement

Conducted emissions measurements were made in accordance with section 11, "Measurement of Information Technology Equipment" of ANSI C63.4-2009. The measurement were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 μH LISN as the input transducer to a Spectrum Analyzer or a Field Intensity Meter. The measurements were made with the detector set for "Peak" amplitude within a bandwidth of 10 kHz or for "quasi-peak" within a bandwidth of 9 kHz.

The line-conducted emission test is conducted inside a shielded anechoic chamber room with 1.0 m x 1.5 m x 0.8 m wooden table, which is placed 40 cm away from the vertical wall, and 1.5 m away from the sidewall of the chamber room. Two LISNs are bonded to the shielded room. The EUT is powered from the PMM LISN and the support equipment is powered from the LISN. Power to the LISNs is filtered by a noise cut power line filters. All electrical cables are shielded by braided tinned steel tubing with inner ϕ 1.2 cm. If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and these supply lines will be connected to the LISN. All interconnecting cables more than 1.0 m were shortened by non-inductive bundling (serpentine fashion) to a 1m length. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the Spectrum Analyzer to determine the frequency producing the max. Emission from the EUT. The frequency producing the max. Level was reexamined using the detector function set to the CISPR Quasi-Peak mode by manual, after scanned by automatic Peak mode from 0.15 MHz to 30 MHz. The bandwidth of the Spectrum Analyzer was set to 9 kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Each emission was maximized by switching power lines, varying the mode of operation or resolution, clock or data exchange speed, if applicable, whichever determined the worst-case emission. Each emission reported was calibrated using self-calibrating mode.

Photographs of the worst-case emission can be seen in photographs of conducted emission test setup.

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3.2 Radiated Emission Measurement

Preliminary measurements were made at indoors 3-meter semi EMC Anechoic Chamber using broadband antennas, broadband amplifier, and spectrum analyzer to determine the emission frequencies producing the maximum EME.

Appropriate precaution was taken to ensure that all emissions from the EUT were maximized and investigated. The system configurations, mode of operation, turntable azimuth with respect to the antenna were noted for each frequency found. The spectrum was scanned from 30 MHz to 1 000 MHz using bi-log antenna and above 1 000 MHz, linearly polarized double ridge horn antennas were used. Above 1 GHz, linearly polarized double ridge horn antennas were used. The measurements were performed with three frequencies, which were selected as bottom, middle, and top frequency in the operating band. Emission level from the EUT with various configurations was examined on the spectrum analyzer connected with the RF amplifier and plotted graphically. Final measurements were made outdoors open site at 3-meter test range using biconical and log periodic, Horn antenna. The output from the antenna was connected, via a preselector or a preamplifier, to the input of the EMI Measuring Receiver and Spectrum analyzer (for above 25 GHz). The detector function was set to the quasi-peak or peak mode as appropriate. The measurement bandwidth on the Field strength receiver was set to at least 120 kHz (1MHz for measurement above 1 GHz), with all post-detector filtering no less than 10 times the measurement bandwidth. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition.

Each frequency found during preliminary measurement was examined and investigated as the same set up and configuration which produced the maximum emission The EUT, support equipment and interconnecting cables were configured to the set-up producing the maximum emission for the frequency and were placed on top of a 0.8 m high non-metallic 1.0 m x 1.5 m table. The turntable containing the system was rotated and the antenna height was varied 1 to 4 meters and stopped at the azimuth or height producing the maximum emission.

Varying the mode of operating frequencies of the EUT maximized each emission. The system was tested in all the three orthogonal planes and changing the polarity of the antenna. The worst-case emissions are recorded in the data tables. If necessary, the radiated emission measurement could be performed at a closer distance to ensure higher accuracy and the results were extrapolated to the specified distance using an inverse linear distance extrapolation factor (20 dB/decade) as per section 15.31(f).

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4. TEST CONDITION

4.1 Test Configuration

The device was configured for testing in a typical fashion (as a customer would normally use it). During the tests, the EUT and the supported equipments were installed to meet FCC requirement and operated in a manner, which tends to maximize its emission level in a typical application.

Radiated Emission Test

Preliminary radiated emission tests were conducted using the procedure in ANSI C63.4/2009 Clause 8.3.1.1 to determine the worst operating condition. Final radiated emission tests were measured at 3-meter open field test site. To complete the test configuration required by the FCC, the EUT was tested in all three orthogonal planes.

4.2 EUT operation

EUT was tested according to the operation modes provided by the specifications given by the manufacturer, and reported the worst emissions.

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5. TEST RESULTS

5.1 Summary of Test Results

The measurement results were obtained with the EUT tested in the conditions described in this report. Detailed measurement data and plots showing the maximum emission of the EUT are reported.

FCC Rule	Description of Test	Result
2.1046 24.132 90.635	RF Power Output	Pass
2.1049 24.131 90.209	Occupied Bandwidth	Pass
2.1051 24.133 90.210	Spurious Emission at Antenna Terminals	Pass
2.1053 24.133 90.210(j)	Field Strength of Spurious Radiation	Pass
2.1055 24.135 90.213	Frequency Stability	Pass
15.209	Field Strength of Spurious Radiation in Receiving Mode	Pass
15.207	Power Line Conducted Emission	Pass
2.1047 24.133 90.210	Emission Mask & Modulation characteristic	Pass

The data collected shows that the product complies with technical requirements of the Part 24D & 90 of the FCC Rules.

Note: Modification to EUT

The device tested is not modified anything, mechanical or circuits to improve EMI status during a measurement. No EMI suppression device(s) was added and/or modified.

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5.2 RF Power Output

EUT	ReFlex Telemetry Device / M1503
Test Date	June 21, 2011
Operating Condition	Continues TX
Environment Condition	26 °C/ 53 % R.H.
Result	Passed

5.2.1 Definition

The conducted carrier power output rating for a transmitter is the power available at the output terminals of the transmitter when the output terminals are connected to the standard transmitter load.

5.2.2 Specification

FCC Rules Part 2, Section 2.1046
FCC Rules Part 24, Section 24.132
FCC Rules Part 90, Section 90.635

5.2.3 Method of Measurement

ANSI/TIA-603-C-2004 Section 2.2.1

5.2.4 Measurement Set-Up

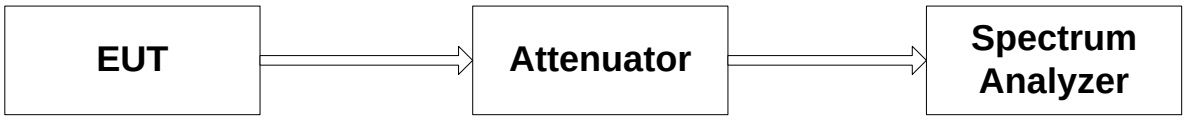

Fig-1

5.2.5 Test Equipment List

Equipment	Model Name	Manufacture
EUT	M1503	HUNETEC
Attenuator	SA18N25WA	FAIRVIEW MICROWAVE INC.
Spectrum Analyzer	FSP13	ROHDE & SCHWARZ

5.2.6 Test Procedure

① Connect the equipment as Fig-1.
② Measure the transmitter output power.
③ RBW 1 MHz, VBW 1 MHz, Max Hold
④ Measure ERP = Measured Power + Antenna Gain

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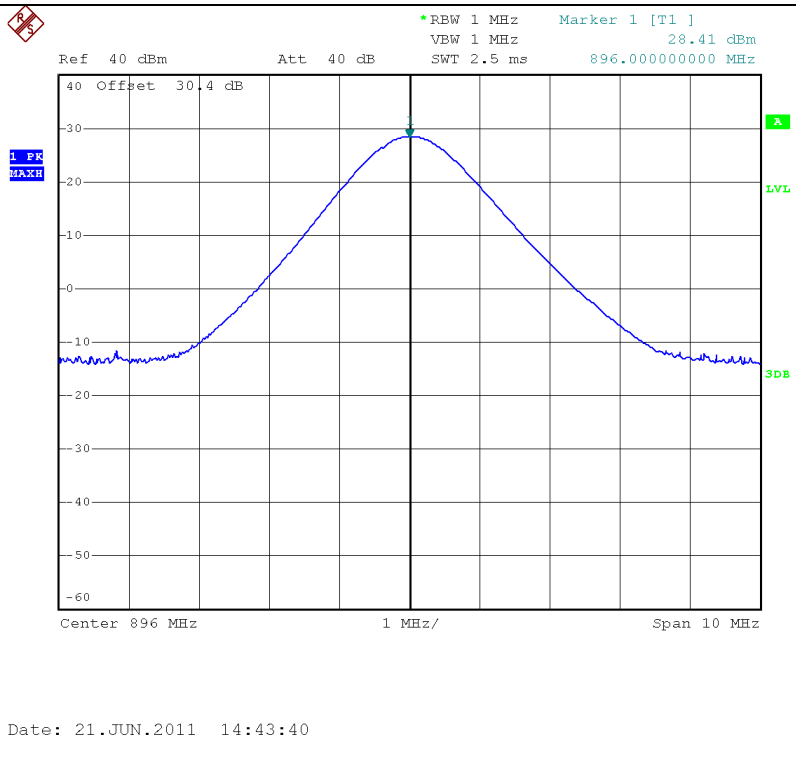
5.2.7 Test Result

Channel	Frequency (MHz)	Measured Power (mW)	ERP Limit	Antenna Gain (dBd)	Measured ERP (dBm)	Measured ERP (mW)
Low	896.0	693.5	100W	-4	24.41	276.1
Middle	899.0	663.8	100W	-4	24.22	264.3
High	902.0	693.5	7W	-4	24.41	276.1

5.2.8 Plot of RF Power Output

Frequency	RF Power Output
896 MHz	

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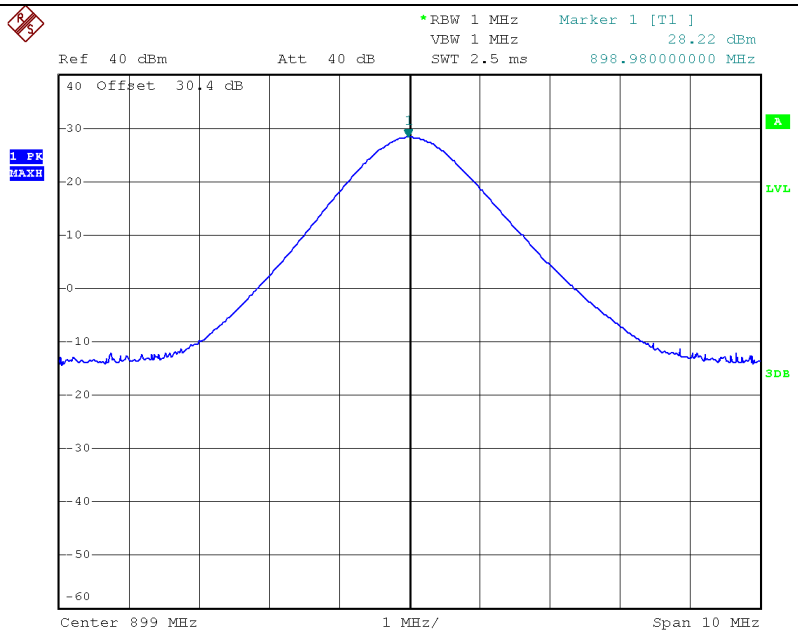
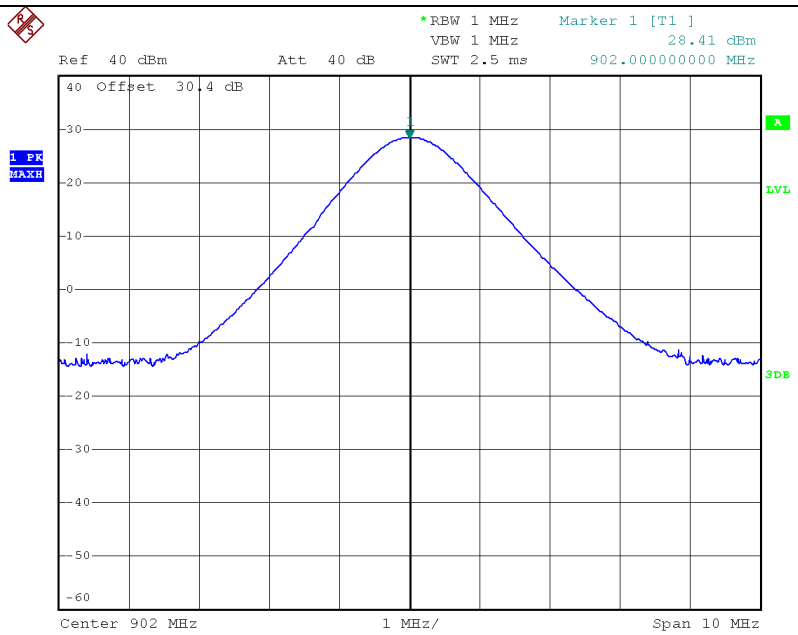
Frequency	RF Power Output
899 MHz	

902 MHz	

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5.3 Occupied Bandwidth

EUT	ReFlex Telemetry Device / M1503
Test Date	June 21, 2011
Operating Condition	Continues TX
Environment Condition	26 °C/ 53 % R.H.
Result	Passed

5.3.1 Definition

The transmitter sideband spectrum denotes the sideband power produced at a discrete frequency separation from the carrier up to the test bandwidth due to all sources of unwanted noise within the transmitter in a modulated condition.

5.3.2 Specification

FCC Rules Part 2, Section 2.1049
FCC Rules Part 24, Section 24.131
FCC Rules Part 90, Section 90.209

5.3.3 Method of Measurement

ANSI/TIA-603-C-2004 Section 2.2.11

5.3.4 Measurement Set-Up

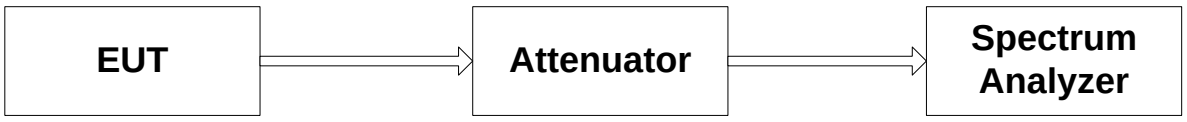

Fig-2

5.3.5 Test Equipment List

Equipment	Model Name	Manufacture
EUT	M1503	HUNETEC
Attenuator	SA18N25WA	FAIRVIEW MICROWAVE INC.
Spectrum Analyzer	FSP13	ROHDE & SCHWARZ

5.3.6 Test Procedure

① Connect the equipment as Fig-2.
② The test shall be performed using the modulation of the EUT.

5.3.7 Limit

① Authorized bandwidth (13.6 kHz)
② Authorized bandwidth (10.0 kHz)

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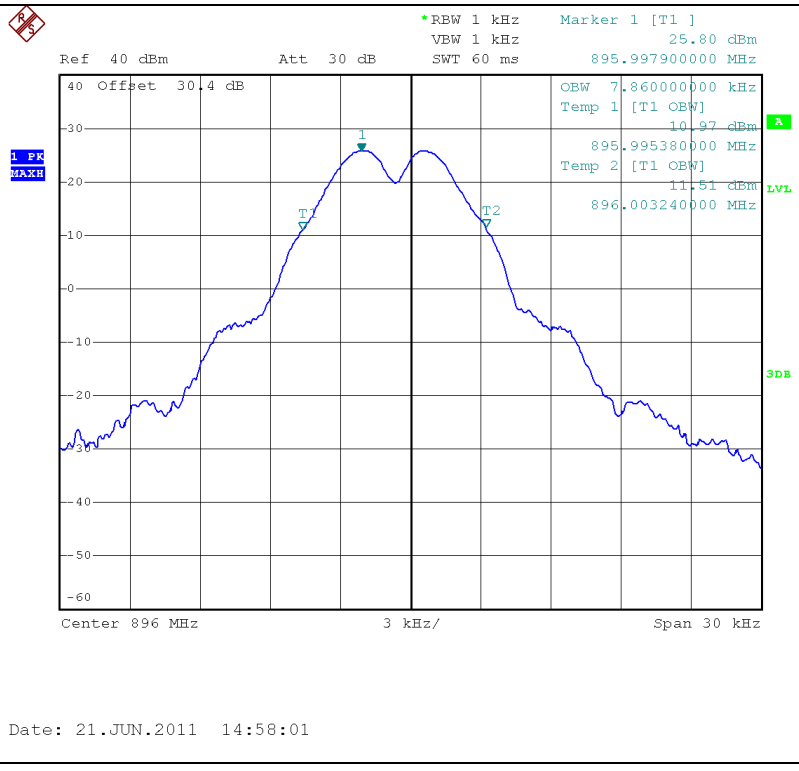
5.3.8 Test Result

Channel	Frequency (MHz)	Occupied Bandwidth (kHz)	Authorized Bandwidth (kHz)
Low	896.0	7.86	13.6
Middle	899.0	7.62	13.6
High	902.0	7.74	10.0

5.3.9 Plot of Occupied Bandwidth

Frequency	Occupied Bandwidth
896 MHz	

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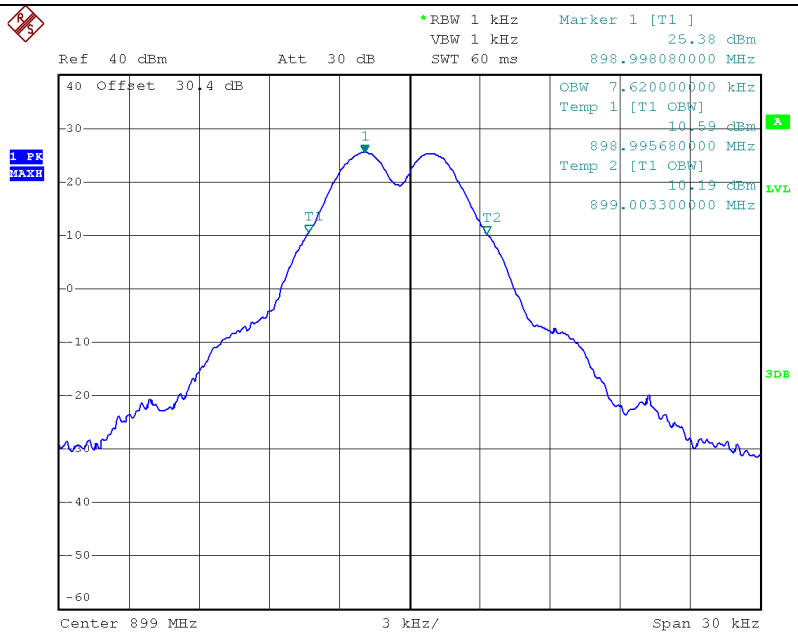
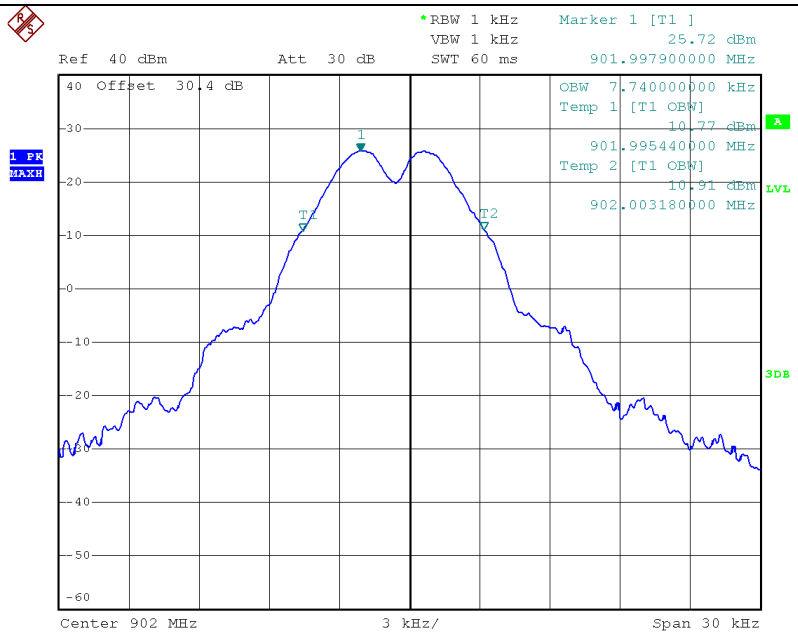
Frequency	Occupied Bandwidth
899 MHz	

902 MHz	

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5.4 Spurious Emission at Antenna Terminals

EUT	ReFlex Telemetry Device / M1503
Test Date	June 23, 2011
Operating Condition	Continues TX
Environment Condition	25 °C/ 53 % R.H.
Result	Passed

5.4.1 Definition

Conducted spurious emissions are emissions at the antenna terminals on a frequency or frequencies that are outside a band sufficient to ensure transmission of information of required quality for the class of communication desired.

5.4.2 Specification

FCC Rules Part 2, Section 2.1051
FCC Rules Part 24, Section 24.133
FCC Rules Part 90, Section 90.210

5.4.3 Method of Measurement

ANSI/TIA-603-C-2004 Section 2.2.13

5.4.4 Measurement Set-Up

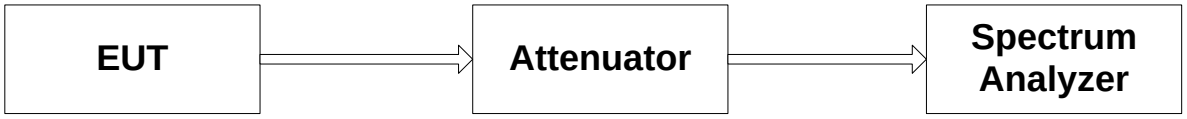

Fig-3

5.4.5 Test Equipment List

Equipment	Model Name	Manufacture
EUT	M1503	HUNETEC
Attenuator	SA18N25WA	FAIRVIEW MICROWAVE INC.
Spectrum Analyzer	FSP13	ROHDE & SCHWARZ

5.4.6 Test Procedure

① Connect the equipment as Fig-3.
② Set the center frequency of the spectrum analyzer to the assigned transmitter frequency, key the transmitter, and set the level of the carrier to the full scale reference line.
③ Measure the spurious emission.
③ RBW 1 MHz, VBW 1 MHz, Max Hold

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5.4.7 Limit

① 896 MHz ~ 901 MHz / “43 + 10log(P) dBc = -13 dBm”
② 901 MHz ~ 902 MHz / “43 + 10log(P) dBc = -13 dBm”

5.4.8 Test Result

Channel	Frequency (MHz)	Measured Value (dBm)	Limit (dBm)	Margin (dB)
Low	896.0	+28.5	-	-
	2 688.0	-25.9	-13.0	-12.9
	3 584.0	-19.1		-6.1
	4 480.0	-25.4		-12.4
Middle	899.0	+28.1	-	-
	1 798.0	-29.9	-13.0	-16.9
	2 697.0	-23.2		-10.2
	3 596.0	-20.3		-7.3
High	902.0	+28.1	-	-
	1 804.0	-27.9	-13.0	-14.9
	2 706.0	-20.3		-7.3
	3 608.0	-20.1		-7.1

● The other emissions below noise floor of -30 dBm.

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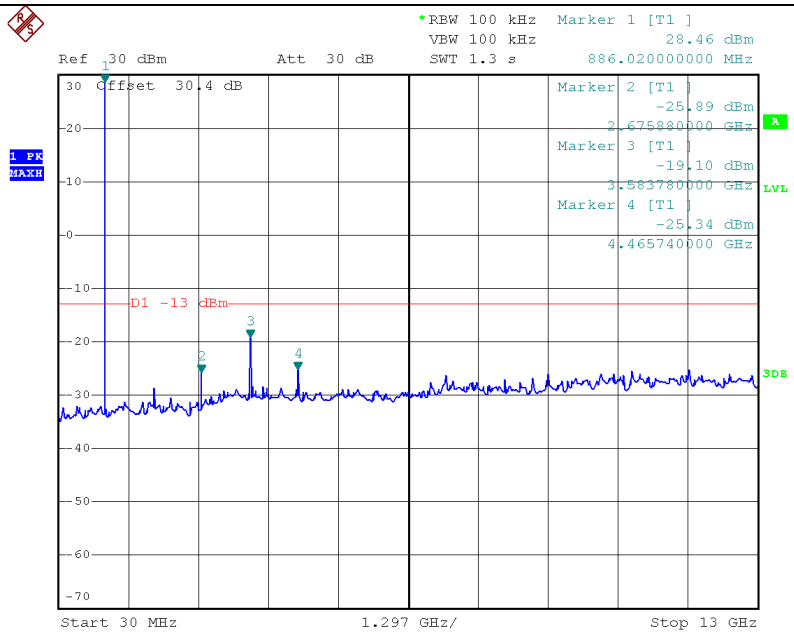
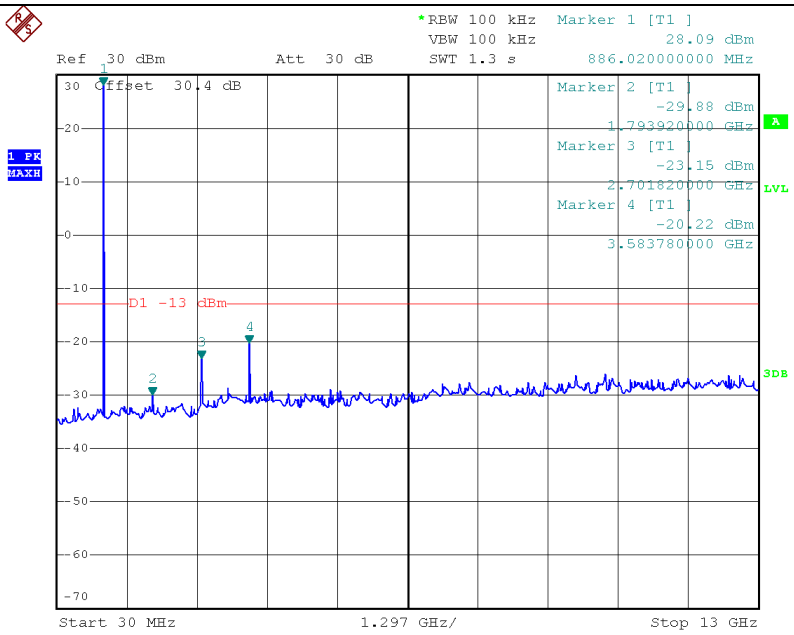
5.4.9 Plot of Spurious Emission at Antenna Terminals

Frequency	Spurious Emission at Antenna Terminals
896 MHz	
899 MHz	

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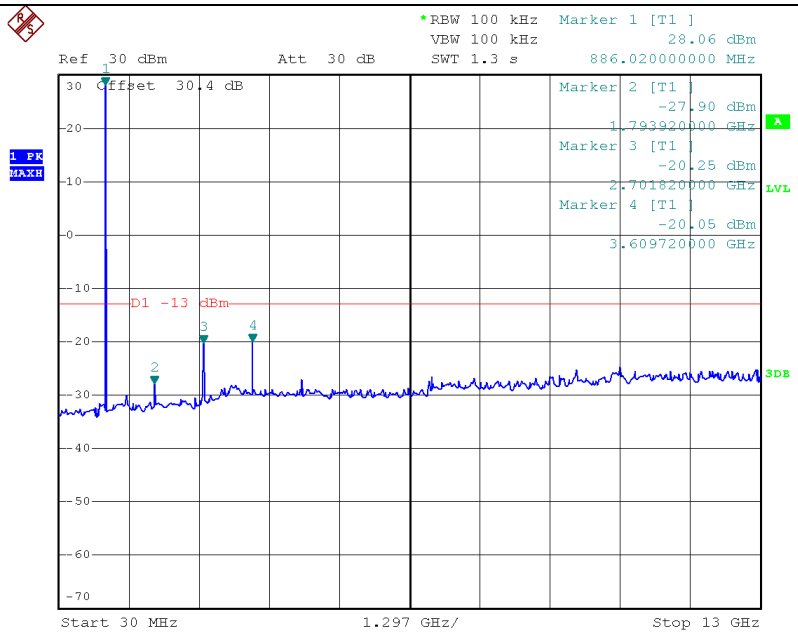
Frequency	Spurious Emission at Antenna Terminals
902 MHz	

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5.5 Field Strength of Spurious Radiation

EUT	ReFlex Telemetry Device / M1503
Test Date	June 22, 2011
Operating Condition	Continues TX
Environment Condition	27 °C/ 53 % R.H.
Result	Passed

5.5.1 Definition

Radiated spurious emissions are emissions from the equipment when transmitting into a nonradiating load on a frequency or frequencies that are outside an occupied band sufficient to ensure transmission of information of required quality for the class of communications desired.

5.5.2 Specification

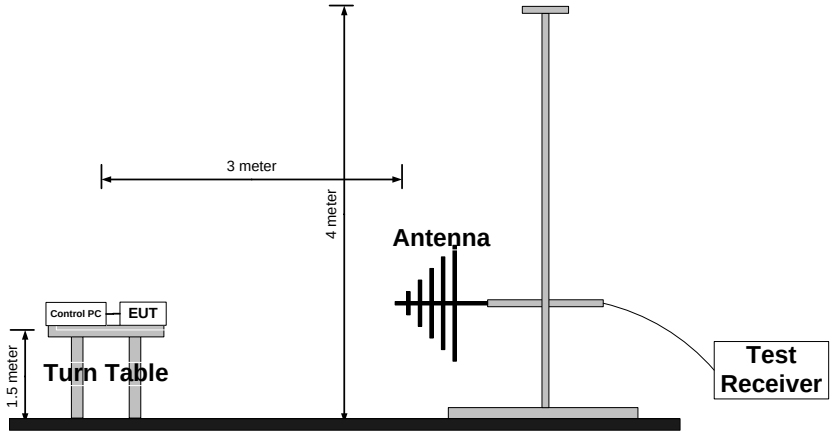
FCC Rules Part 2, Section 2.1053
FCC Rules Part 24, Section 24.133
FCC Rules Part 90, Section 90.210(j)

5.5.3 Method of Measurement

ANSI/TIA-603-C-2004 Section 2.2.12

5.5.4 Measurement Set-Up

Step 1. Measurement of Field Strength (Fig-4.1)



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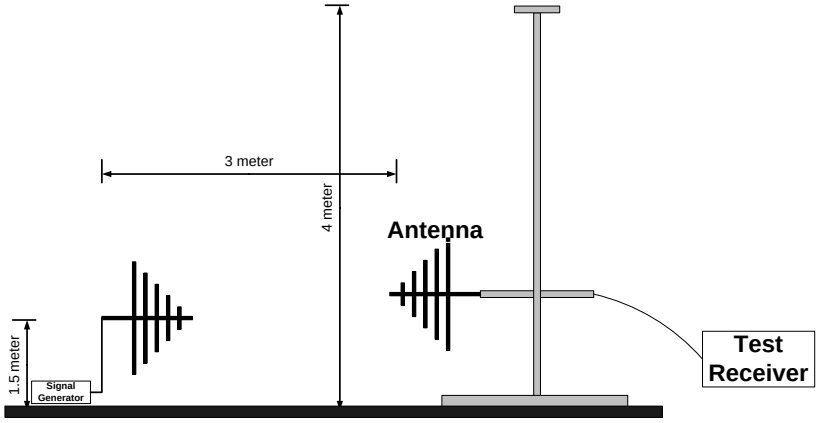
Step 2. Measurement of ERP (Fig-4.2)



5.5.5 Test Equipment List

Equipment	Model Name	Manufacture
EUT	M1503	HUNETEC
Receiver	ESVN 30	ROHDE & SCHWARZ
Receiver	ESPI	ROHDE & SCHWARZ
Signal Generator	GT9000	GIGATRONICS
Bilog Antenna	VULB 9160	SCHWARZBECK
Bilog Antenna	VULB 9161	SCHWARZBECK
Horn Antenna	BBHA 9120	SCHWARZBECK
Horn Antenna	BBHA9120	SCHWARZBECK

5.5.6 Test Procedure

① X, Y, Z axis, tested carried out to find the maximum condition.
② Maximum conditions: Z-Axis
③ As a result of the Z axis write a report.

5.5.7 Test Procedure

① Connect the equipment as Fig-4-1.
② Place the transmitter to be tested on the turntable in the standard test site
③ The transmitter is transmitting into a nonradiating load that is placed on the turntable. The RF cable to this load should be of minimum length. For transmitters with integral antennas, the tests are to be run with the unit operating into the integral antenna.
④ For each spurious measurement the test antenna should be adjusted to the correct length for the frequency involved. This length may be determined from a calibration ruler supplied with the equipment. Measurements shall be made from the lowest radio frequency generated in the equipment to the tenth harmonic of the carrier, except for the region close to the carrier equal to ± the test bandwidth.
⑤ Key the transmitter.
⑥ For each spurious frequency, raise and lower the test antenna from 1 m to 4 m to obtain a maximum reading on the spectrum analyzer with the test antenna at horizontal polarity. Then the turntable should be rotated 360° to determine the maximum reading. Repeat this procedure to

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obtain the highest possible reading. Record this maximum reading.

⑦ Repeat step ⑥ for each spurious frequency with the test antenna polarized vertically.

⑧ Reconnect the equipment as Fig-4.2.

⑨ Remove the transmitter and replace it with a substitution antenna (the antenna should be half-wavelength for each frequency involved). The center of the substitution antenna should be approximately at the same location as the center of the transmitter. At the lower frequencies, where the substitution antenna is very long, this will be impossible to achieve when the antenna is polarized vertically. In such case the lower end of the antenna should be 0.3 m above the ground.

⑩ Feed the substitution antenna at the transmitter end with a signal generator connected to the antenna by means of a nonradiating cable. With the antennas at both ends horizontally polarized, and with the signal generator tuned to a particular spurious frequency, raise and lower the test antenna to obtain a maximum reading at the spectrum analyzer. Adjust the level of the signal generator output until the previously recorded maximum reading for this set of conditions is obtained. This should be done carefully repeating the adjustment of the test antenna and generator output.

⑪ Repeat step ⑩ with both antennas vertically polarized for each spurious frequency.

⑫ Calculate power in dBm into a reference ideal half-wave dipole antenna by reducing the readings obtained in steps ⑩ and ⑪ by the power loss in the cable between the generator and the antenna, and further corrected for the gain of the substitution antenna used relative to an ideal half-wave dipole antenna by the following formula :

Pd(dBm) = Pg(dBm) – cable loss (dB) + antenna gain (dB)

where: **Pd** is the dipole equivalent power and

Pg is the generator output power into the substitution antenna.

5.5.8 Limit

① 896 MHz ~ 901 MHz / “43 + 10log(P) dBc = -13 dBm”

② 901 MHz ~ 902 MHz / “43 + 10log(P) dBc = -13 dBm”

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5.5.9 Test Result

ERP Power Frequency Tuned (MHz)	Max. E-Field of EUT (dB(μV/m))	Antenna Polarization (V/H)	Signal GEN. Power (dBm)	Dipole Gain (dBd)	Measured ERP Power (dBm)	Limit (dBm)	Margin (dB)
Low Channel / 896 MHz							
896.00	100.34	H	+17.47	3.80	+21.27	-	-
875.25	42.74	H	-64.26	3.80	-60.46	-13.00	-47.46
952.09	49.38	H	-57.62	3.80	-53.82		-40.82
1 792.06	61.99	H	-45.01	7.80	-37.21		-24.21
2 687.88	54.57	H	-52.43	8.80	-43.63		-30.63
3 582.49	70.68	V	-36.32	9.80	-26.52		-13.52
Middle Channel / 899 MHz							
899.00	100.37	H	+17.57	3.80	+21.37	-	-
878.32	42.71	H	-64.29	3.80	-60.49	-13.00	-47.49
932.27	33.83	H	-73.17	3.80	-69.37		-56.37
962.16	49.46	H	-57.54	3.80	-53.74		-40.74
1 797.97	62.62	H	-44.38	7.80	-36.58		-23.58
2 699.71	59.30	V	-47.70	8.80	-38.9		-25.90
3 594.93	71.96	V	-35.04	9.80	-25.24		-12.24
High Channel / 902 MHz							
902.0	100.39	V	+17.61	3.80	+21.41	-	-
1 803.91	61.87	H	-45.13	7.80	-37.33	-13.00	-24.33
2 708.63	59.51	V	-47.49	8.80	-38.69		-25.69
3 607.41	71.04	V	-35.96	9.80	-26.16		-13.16

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5.6 Frequency Stability

EUT	ReFlex Telemetry Device / M1503
Test Date	June 22, 2011
Operating Condition	Non-Modulation Mode
Result	Passed

5.6.1 Definition

The carrier frequency stability is the ability of the transmitter to maintain an assigned carrier frequency.

5.6.2 Specification

FCC Rules Part 2, Section 2.1055
FCC Rules Part 24, Section 24.135
FCC Rules Part 90, Section 90.213

5.6.3 Method of Measurement

ANSI/TIA-603-C-2004 Section 2.2.2

5.6.4 Measurement Set-Up

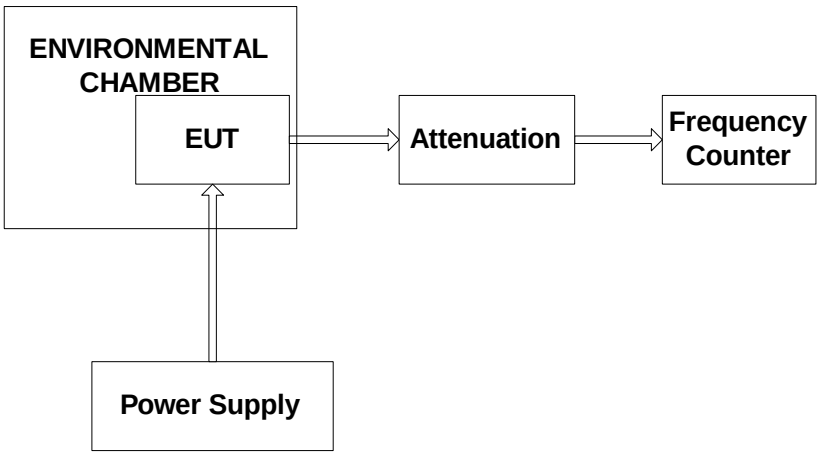

Fig.5

5.6.5 Test Equipment List

Equipment	Model Name	Manufacture
EUT	M1503	HUNETEC
Attenuator	SA18N25WA	FAIRVIEW MICROWAVE INC.
Frequency Counter	R5372	ADVENTEST
Environmental Chamber	SJ1013-TH	SEOJIN

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5.6.6 Test Procedure

① Connect the equipment as Fig-5.
② Record the carrier frequency of the transmitter as MCFMHz.
③ Calculate the ppm frequency error.

5.6.7 Limit

① 1 ppm
② 1.5 ppm

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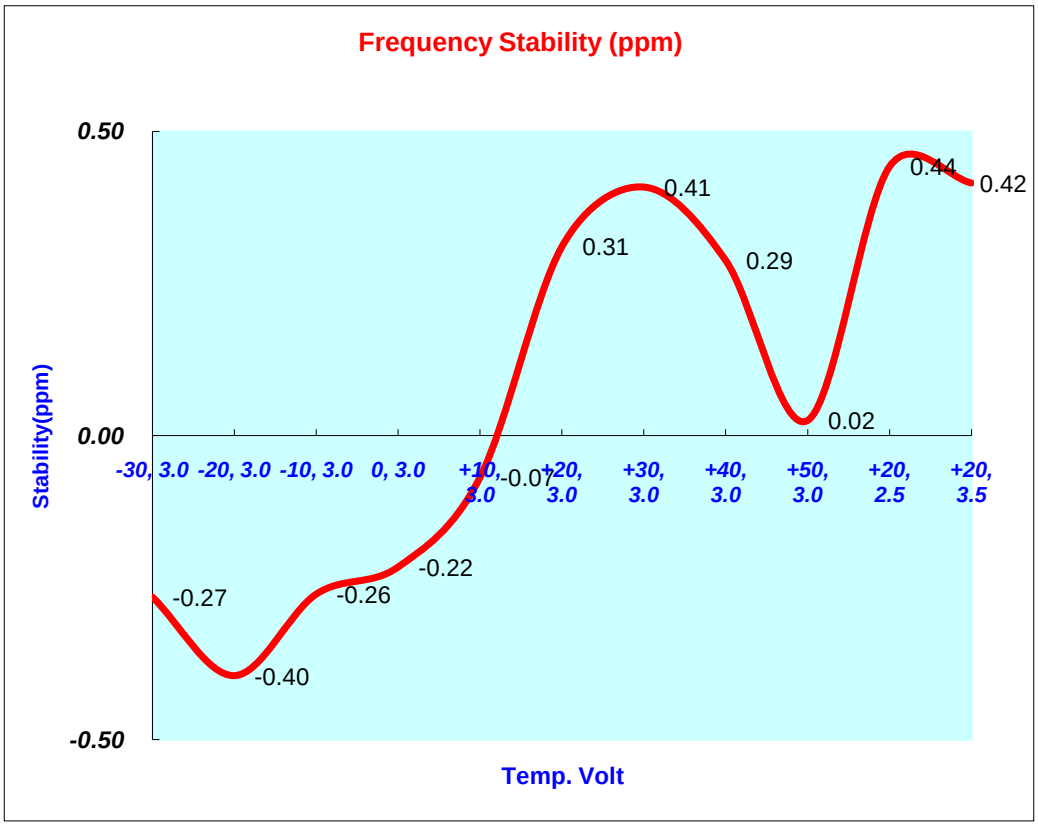
5.6.8 Test Result

5.6.8.1 Low Channel (896 MHz) / Data Table

Voltage (%)	Power Supply (Vdc)	Temperature (ºC)	Frequency (Hz)	Deviation (ppm)	Limit (ppm)
100 %	3.70	-30	895 999 762	-0.27	1.50
100 %		-20	895 999 646	-0.40	
100 %		-10	895 999 766	-0.26	
100 %		0	895 999 806	-0.22	
100 %		+10	895 999 938	-0.07	
100 %		+20	896 000 278	0.31	
100 %		+30	896 000 366	0.41	
100 %		+40	896 000 258	0.29	
100 %		+50	896 000 022	0.02	
High 115 %	4.26	+20	896 000 396	0.44	
Low 85 %	3.15	+20	896 000 372	0.42	

5.6.8.2 Low Channel (896 MHz) / Graph



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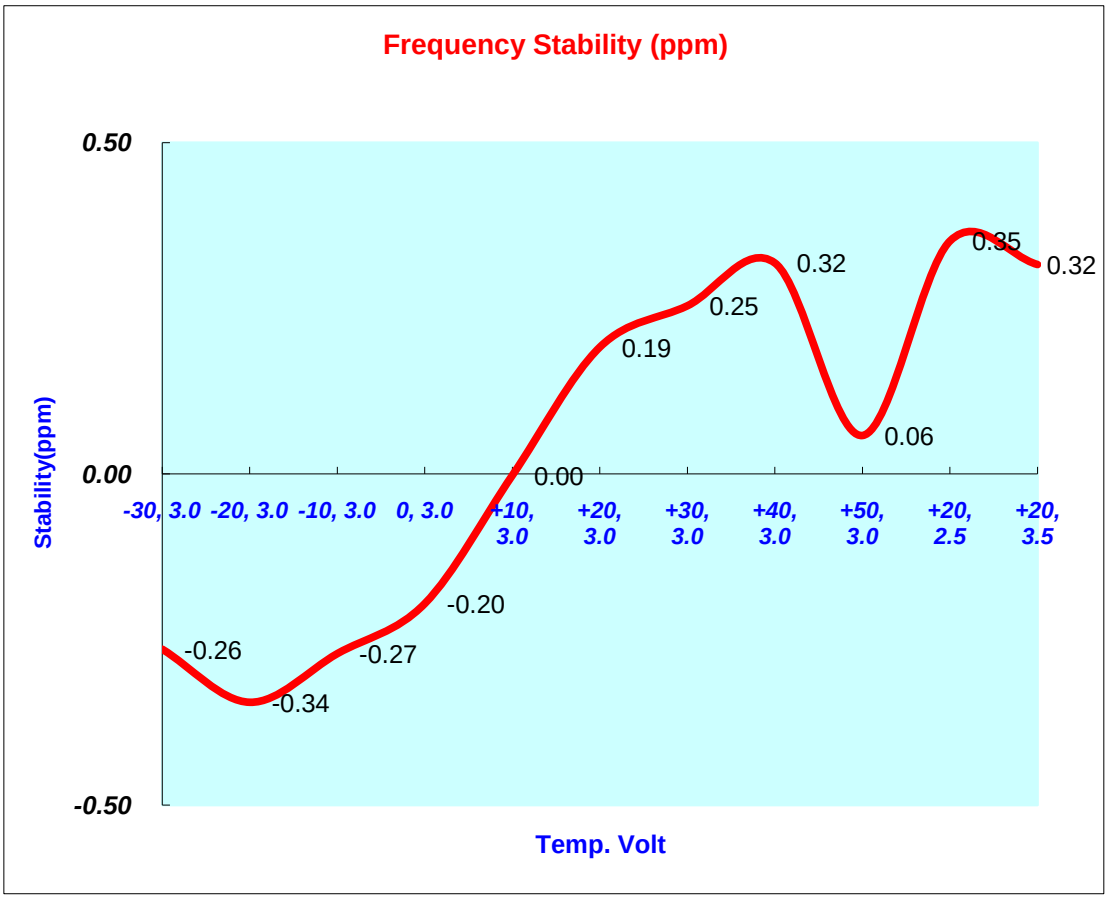
5.6.9 Test Result

5.6.9.1 Middle Channel (899 MHz) / Data Table

Voltage (%)	Power Supply (Vdc)	Temperature (ºC)	Frequency (Hz)	Deviation (ppm)	Limit (ppm)
100 %	3.70	-30	898 999 762	-0.26	1.50
100 %		-20	898 999 690	-0.34	
100 %		-10	898 999 756	-0.27	
100 %		0	898 999 824	-0.20	
100 %		+10	898 999 998	0.00	
100 %		+20	899 000 172	0.19	
100 %		+30	899 000 228	0.25	
100 %		+40	899 000 286	0.32	
100 %		+50	899 000 052	0.06	
High 115 %	4.26	+20	899 000 316	0.35	
Low 85 %	3.15	+20	899 000 284	0.32	

5.6.9.2 MIDDLE Channel (899 MHz) / Graph



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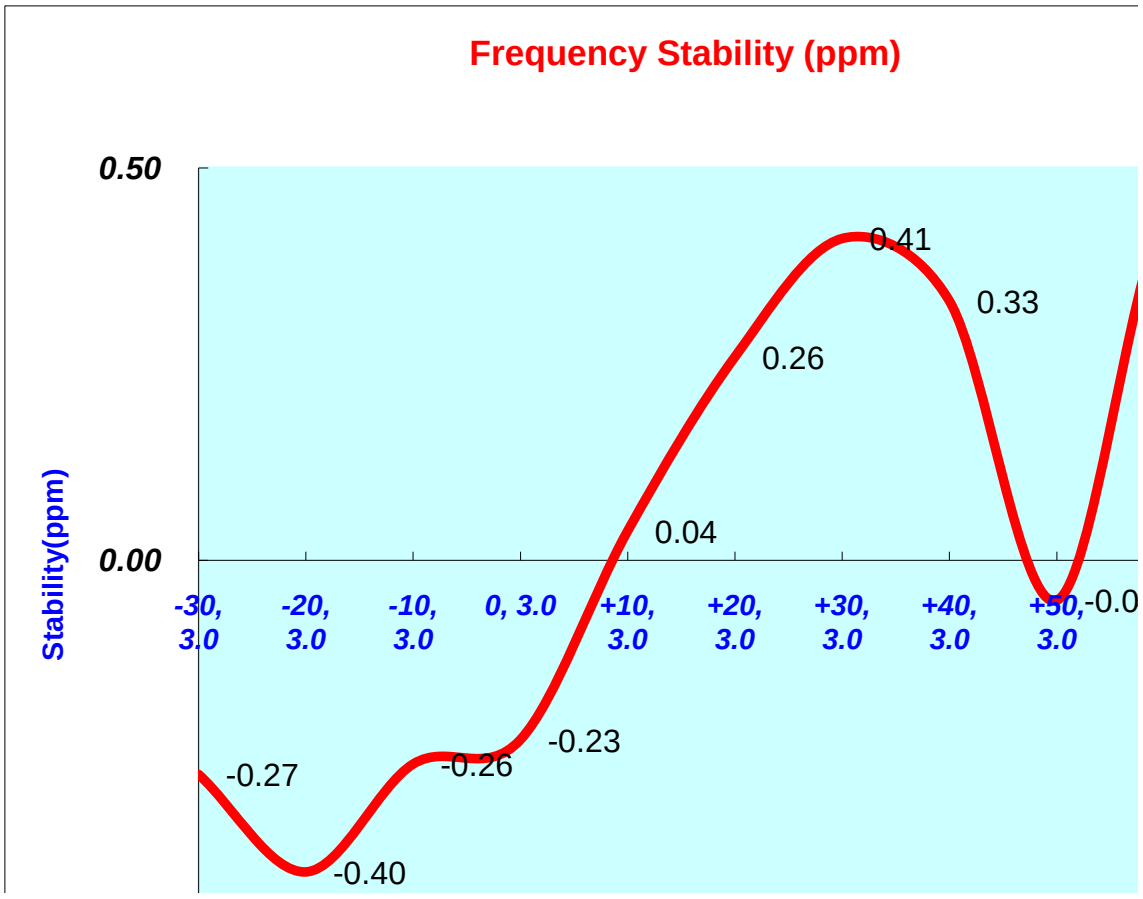
5.6.10 Test Result

5.6.10.1 High Channel (902 MHz) / Data Table

Voltage (%)	Power Supply (Vdc)	Temperature (ºC)	Frequency (Hz)	Deviation (ppm)	Limit (ppm)
100 %	3.70	-30	901 999 754	-0.27	1.00
100 %		-20	901 999 642	-0.40	
100 %		-10	901 999 766	-0.26	
100 %		0	901 999 794	-0.23	
100 %		+10	902 000 034	0.04	
100 %		+20	902 000 234	0.26	
100 %		+30	902 000 370	0.41	
100 %		+40	902 000 298	0.33	
100 %		+50	901 999 954	-0.05	
High 115 %	4.26	+20	902 000 394	0.44	
Low 85 %	3.15	+20	902 000 392	0.43	

5.6.10.2 High Channel (902 MHz) / Graph



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5.7 Field Strength of Spurious Radiation in Receiving Mode

EUT	ReFlex Telemetry Device / M1503
Test Date	July 01, 2011
Operating Condition	Rx Mode, Tx Mode
Environment Condition	23 °C/ 49 % R.H. (PC Connection TX Mode) 24 °C/ 47 % R.H. (PC Connection RX Mode) 21 °C/ 52 % R.H. (Stand-Alone RX Mode)
Result	Passed

5.7.1 Definition

Radiated spurious emissions are emissions from the equipment when transmitting into a nonradiating load on a frequency or frequencies that are outside an occupied band sufficient to ensure transmission of information of required quality for the class of communications desired.

5.7.2 Specification

FCC Rules Part 15, Section 15.209

5.7.3 Method of Measurement

ANSI/TIA-603-C-2004 Section 2.2.12

5.7.4 Measurement Set-Up

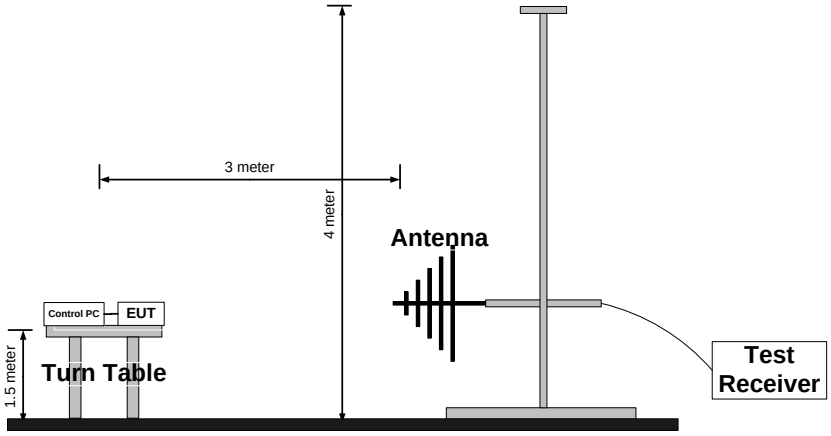

Fig.6

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5.7.5 Test Equipment List

Equipment	Model Name	Manufacture	Serial No	Cal Due Date
EMI Receiver	ESVN 30	ROHDE & SCHWARZ	832854/010	01. 24. 2012
Test Receiver	ESPI	ROHDE & SCHWARZ	100012	01. 25. 2012
Bilog Antenna	VULB 9161	SCHWARZBECK	9160-3052	06. 29. 2013
Horn Antenna	BBHA 9120 D	SCHWARZBECK	BBHA 9120 D 517	10. 04. 2012
Open Site Cable	SUCOTEST 18A	Hubersuhner	8400/18A	N/A
Antenna Master	JAC-3	DAIL EMC	N/A	N/A
Antenna Turntable Controller	JAC-2	JAEMC	N/A	N/A
Chamber Cable	SUCOFLEX 104	Hubersuhner	317392/4	N/A
Chamber Cable	SUCOFLEX 104	Hubersuhner	323837/4	N/A
Antenna Master	N/A	AUDIX	N/A	N/A
Antenna Turntable Controller	ACT	AUDIX	N/A	N/A

5.7.6 Peripherals

Equipment	Model Name	Serial No	Manufacture
Notebook	NT-P560	ZOM793MZ300199L	SAMSUNG
Notebook Adapter	AD-6019	WBA4400243AB /Z0401L9128	DELTA ELECTRONICS, INC.

5.7.7 Test Procedure

① Connect the equipment as Fig-6.
② Place the transmitter to be tested on the turntable in the standard test site
③ The transmitter is transmitting into a nonradiating load that is placed on the turntable. The RF cable to this load should be of minimum length. For transmitters with integral antennas, the tests are to be run with the unit operating into the integral antenna.
④ For each spurious measurement the test antenna should be adjusted to the correct length for the frequency involved. This length may be determined from a calibration ruler supplied with the equipment. Measurements shall be made from the lowest radio frequency generated in the equipment to the tenth harmonic of the carrier, except for the region close to the carrier equal to ± the test bandwidth.
⑤ Key the transmitter.
⑥ For each spurious frequency, raise and lower the test antenna from 1 m to 4m to obtain a maximum reading on the spectrum analyzer with the test antenna at horizontal polarity. Then the turntable should be rotated 360° to determine the maximum reading. Repeat this procedure to obtain the highest possible reading. Record this maximum reading.
⑦ Repeat step ⑥ for each spurious frequency with the test antenna polarized vertically.

5.7.8 Limit

① FCC Rules Part 15, Section 15.209

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5.7.9 Test Result

PC Connection TX Mode

Frequency [MHz]	Reading [dBμV]	Polarization [*H/**V]	Ant.Factor [dB]	Cable Loss +AMP Gain [dB]	Limit [dBμV/m]	Emission Level [dBμV/m]	Margin [dB]
38.42	43.79	V	11.30	-23.67	40.00	31.42	8.58
169.60	42.19	V	12.11	-21.83	40.00	32.47	7.53
238.54	43.40	V	11.06	-20.87	47.00	33.59	13.41
872.18	35.58	H	23.32	-17.67	47.00	41.24	5.76
930.51	34.92	H	23.87	-17.25	47.00	41.54	5.46

Frequency [MHz]	Reading [dBμV]	Polarization [*H/**V]	Ant.Factor [dB/m]	Cable Loss [dB]	Limit [dBμV/m]	Emission Level [dBμV/m]	Margin [dBμV/m]	Remark
1496.59	10.33	H	25.51	5.10	50.00	40.94	9.06	Average
1496.59	21.74	H	25.51	5.10	70.00	52.35	17.65	Peak
1801.93	14.97	H	25.94	5.29	50.00	46.20	3.80	Average
1801.93	16.04	H	25.94	5.29	70.00	47.27	22.73	Peak
2705.65	12.60	H	27.82	6.17	50.00	46.59	3.41	Average
2705.65	13.91	H	27.82	6.17	70.00	47.90	22.10	Peak
3602.41	8.90	H	29.44	6.79	54.00	45.13	8.87	Average
3602.41	15.15	H	29.44	6.79	74.00	51.38	22.62	Peak
4349.84	10.13	H	30.66	7.17	54.00	47.96	6.04	Average
4349.84	14.66	H	30.66	7.17	74.00	52.49	21.51	Peak
4506.36	11.87	H	30.93	7.21	54.00	50.01	3.99	Average
4506.36	16.62	H	30.93	7.21	74.00	54.76	19.24	Peak

Notes
1. * H : Horizontal polarization , ** V : Vertical polarization
2. Emission Level = Reading + Antenna factor + Cable loss
3. Margin value = Limit - Emission Level
4. All other emissions not reported were more than 25 dB below the permitted limit.
5. Measurement uncertainty estimated at ± 5.228 dB.
   The measurement uncertainty is given with a confidence of 95.00 % with the coverage factor, k = 2.

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PC Connection RX Mode

Frequency [MHz]	Reading [dBμV]	Polarization [*H/**V]	Ant.Factor [dB]	Cable Loss +AMP Gain [dB]	Limit [dBμV/m]	Emission Level [dBμV/m]	Margin [dB]
419.11	42.26	V	16.08	-19.84	47.00	38.49	8.51
597.22	38.80	V	20.04	-19.30	47.00	39.54	7.46
652.53	38.43	V	20.63	-18.95	47.00	40.10	6.90

Frequency [MHz]	Reading [dBμV]	Polarization [*H/**V]	Ant.Factor [dB/m]	Cable Loss [dB]	Limit [dBμV/m]	Emission Level [dBμV/m]	Margin [dBμV/m]	Remark
1498.24	9.96	H	25.51	5.10	50.00	40.57	9.43	Average
1498.24	21.30	H	25.51	5.10	70.00	51.91	18.09	Peak
1596.81	8.54	H	25.65	5.17	50.00	39.36	10.64	Average
1596.81	17.82	H	25.65	5.17	70.00	48.64	21.36	Peak
2129.41	8.66	H	26.52	5.57	50.00	40.75	9.25	Average
2129.41	17.09	H	26.52	5.57	70.00	49.18	20.82	Peak
3073.67	8.16	H	28.60	6.45	54.00	43.21	10.79	Average
3073.67	25.29	H	28.60	6.45	74.00	60.34	13.66	Peak
4178.44	8.55	H	30.37	7.14	54.00	46.06	7.94	Average
4178.44	24.45	H	30.37	7.14	74.00	61.96	12.04	Peak
5310.92	9.04	V	32.18	8.22	54.00	49.44	4.56	Average
5310.92	25.57	V	32.18	8.22	74.00	65.97	8.03	Peak
5763.57	9.12	V	32.78	8.56	54.00	50.46	3.54	Average
5763.57	25.66	V	32.78	8.56	74.00	67.00	7.00	Peak

Notes

1. * H : Horizontal polarization , ** V : Vertical polarization
2. Emission Level = Reading + Antenna factor + Cable loss
3. Margin value = Limit - Emission Level
4. All other emissions not reported were more than 25 dB below the permitted limit.
5. Measurement uncertainty estimated at ± 5.228 dB.
   The measurement uncertainty is given with a confidence of 95.00 % with the coverage factor, k = 2.

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Stand-Alone RX Mode

Frequency [MHz]	Reading [dBμV]	Polarization [*H/**V]	Ant.Factor [dB]	Cable Loss +AMP Gain [dB]	Limit [dBμV/m]	Emission Level [dBμV/m]	Margin [dB]
60.07	42.99	V	10.96	-23.80	40.00	30.15	9.85
567.44	33.65	V	19.41	-19.47	47.00	33.59	13.41

Frequency [MHz]	Reading [dBμV]	Polarization [*H/**V]	Ant.Factor [dB/m]	Cable Loss [dB]	Limit [dBμV/m]	Emission Level [dBμV/m]	Margin [dBμV/m]	Remark
1797.97	3.37	V	25.94	5.29	50.00	34.60	15.40	Average
1797.97	11.71	V	25.94	5.29	70.00	42.94	27.06	Peak
1922.59	4.08	H	26.12	5.36	50.00	35.56	14.44	Average
1922.59	12.11	H	26.12	5.36	70.00	43.59	26.41	Peak
3069.41	6.50	H	28.59	6.44	50.00	41.53	8.47	Average
3069.41	26.82	H	28.59	6.44	70.00	61.85	8.15	Peak
3994.36	7.13	V	30.06	7.10	54.00	44.29	9.71	Average
3994.36	25.87	V	30.06	7.10	74.00	63.03	10.97	Peak
5024.44	8.06	H	31.79	7.93	54.00	47.78	6.22	Average
5024.44	25.28	H	31.79	7.93	74.00	65.00	9.00	Peak
5755.58	8.44	H	32.77	8.56	54.00	49.77	4.23	Average
5755.58	25.66	H	32.77	8.56	74.00	66.99	7.01	Peak

Notes

1. * H : Horizontal polarization , ** V : Vertical polarization
2. Emission Level = Reading + Antenna factor + Cable loss
3. Margin value = Limit - Emission Level
4. All other emissions not reported were more than 25 dB below the permitted limit.
5. Measurement uncertainty estimated at ± 5.228 dB.
   The measurement uncertainty is given with a confidence of 95.00 % with the coverage factor, *k* = 2.

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5.8 Power Line Conducted Emission

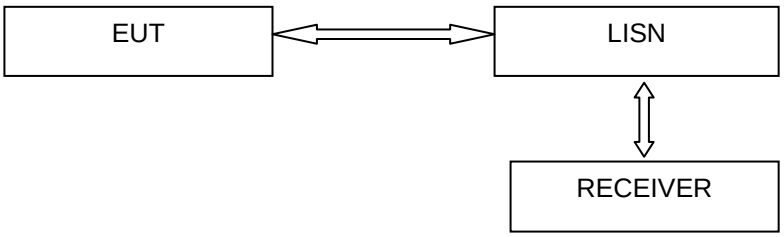
5.8.1 Specification

Conducted Emissions were measured from 150 kHz to 30 MHz with a bandwidth of 9 kHz on the 24 DC power and return leads of the EUT according to the methods defined in FCC Part 15.207.
The EUT was placed on a nonmetallic stand in a shielded room 0.8 meters above the ground plane as shown in section 3.1.5. The interface cables and equipment positioning were varied within limits of reasonable applications to determine the position producing maximum conducted emissions.

5.8.2 Method of Measurement

The EUT was placed on a nonmetallic stand in a shielded room 0.8 meters above the ground plane as shown in section 3.1.5. The interface cables and equipment positioning were varied within limits of reasonable applications to determine the position producing maximum conducted emissions

5.8.3 Measurement Set-Up



5.8.4 Limit

Frequency Range (MHz)	Limit (dB(μV))	
	Quasi-Peak	Average
0.15 ~ 0.5	66 - 56	56 - 46
0.5 ~ 5.0	56	46
5.0 ~ 30.0	60	50

5.8.5 Test Result

EUT	ReFlex Telemetry Device / M1503
Test Date	July 01, 2011
Frequency Range of Test	150 kHz to 30 MHz
Test Standard	FCC Part 15.207
Temperature/Humidity	24 °C/ 42 % R.H.
Result	Passed

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5.8.6 Conducted Emission Test Data

PC Connection TX Mode

Freq [MHz]	Correcton		Phase [H/N]	Quasi-Peak Mode				Average Mode			
	AMN	C.L		Limit [dBuV]	Reading [dBuV]	Emission Level [dBuV]	Margin [dBuV]	Limit [dBuV]	Reading [dBuV]	Emission Level [dBuV]	Margin [dBuV]
0.194	0.06	0.03	H	64.90	57.52	57.61	-7.29	54.90	44.98	45.07	-9.83
0.258	0.07	0.16	H	63.00	48.84	49.07	-13.93	53.00	37.11	37.34	-15.66
0.386	0.08	0.24	H	59.30	40.06	40.38	-18.92	49.30	29.81	30.13	-19.17
0.780	0.08	0.30	N	56.00	37.69	38.07	-17.93	46.00	33.81	34.19	-11.81
1.612	0.03	0.49	H		39.07	39.59	-16.41		35.47	35.99	-10.01
3.764	0.03	0.73	N		39.77	40.53	-15.47		35.96	36.72	-9.28
5.516	0.05	0.88	N	60.00	42.98	43.91	-16.09	50.00	40.18	41.11	-8.89
10.580	0.06	1.05	H		38.06	39.17	-20.83		33.46	34.57	-15.43
26.212	0.17	1.53	H		32.98	34.68	-25.32		23.04	24.74	-25.26

PC Connection RX Mode

Freq [MHz]	Correcton		Phase [H/N]	Quasi-Peak Mode				Average Mode			
	AMN	C.L		Limit [dBuV]	Reading [dBuV]	Emission Level [dBuV]	Margin [dBuV]	Limit [dBuV]	Reading [dBuV]	Emission Level [dBuV]	Margin [dBuV]
0.150	0.06	0.03	N	66.00	45.10	45.19	-20.81	56.00	21.05	21.14	-34.86
0.194	0.06	0.03	N	64.90	51.79	51.88	-13.02	54.90	40.52	40.61	-14.29
0.454	0.07	0.28	N	57.40	37.72	38.07	-19.33	47.40	31.65	32.00	-15.40
0.780	0.08	0.30	N	56.00	37.84	38.22	-17.78	46.00	34.45	34.83	-11.17
2.796	0.04	0.59	N		41.81	42.44	-13.56		37.93	38.56	-7.44
4.688	0.04	0.83	H		35.51	36.38	-19.62		31.48	32.35	-13.65
5.460	0.05	0.88	N	60.00	43.06	43.99	-16.01	50.00	40.29	41.22	-8.78
10.100	0.08	1.03	H		38.44	39.55	-20.45		35.37	36.48	-13.52
21.524	0.06	1.43	N		25.24	26.73	-33.27		18.29	19.78	-30.22

Notes:
1. All modes of operation were investigated and the worst-case emissions are reported.
See the plots in next 2 pages.
2. Line N = (Neutral), Line H = (Hot)
3. Measurement uncertainty estimated at ± 3.736 dB.
The measurement uncertainty is given with a confidence of 95.00 % with the coverage factor, k = 2
4. The detail plot data is refer to 6.1.

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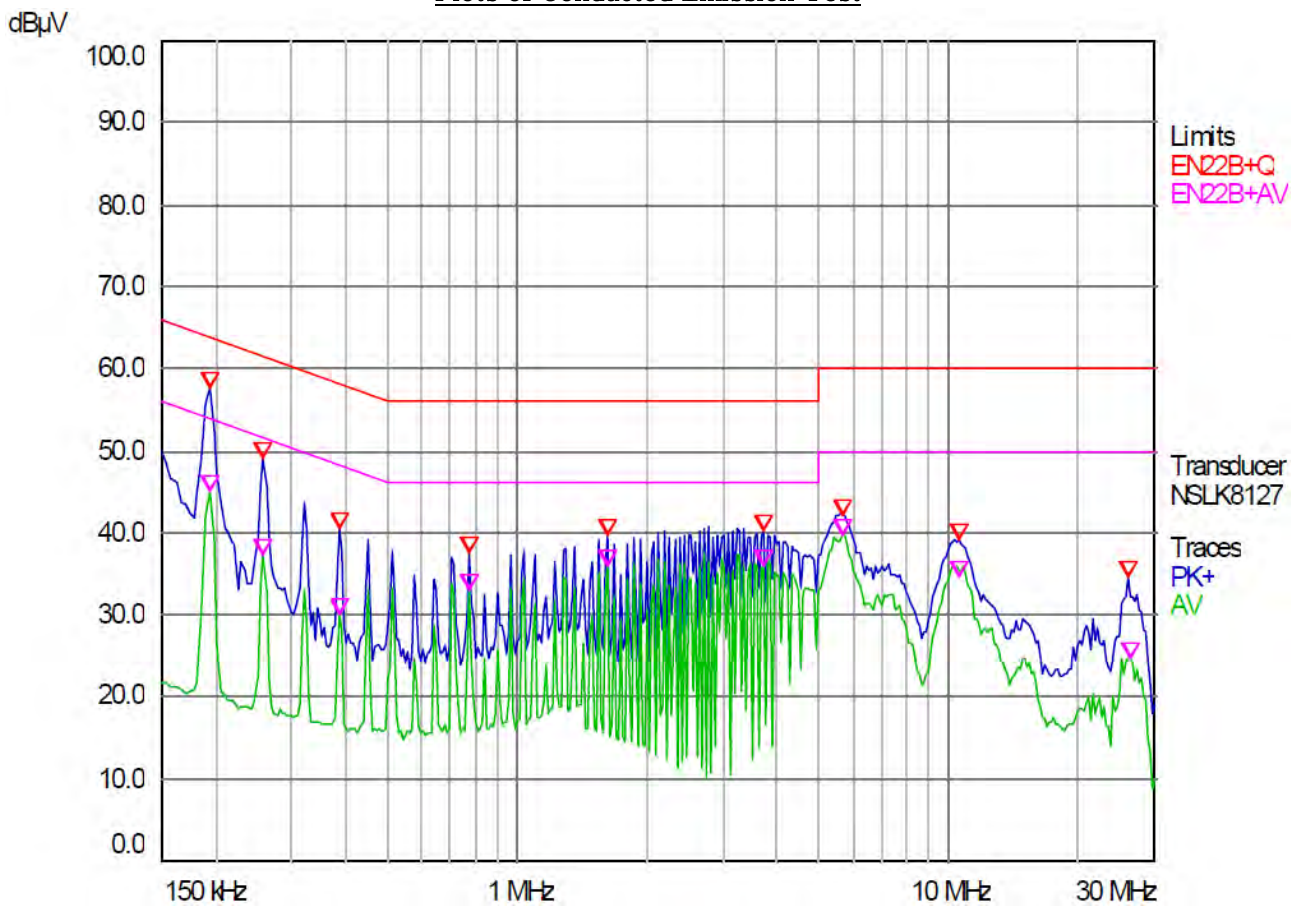
Plots of Conducted Emission Test



Test Model: M1503
Test Mode: HOT(PC Connection TX Mode)
Classification: FCC Part15 Subpart B Section 15.207(a) Class B

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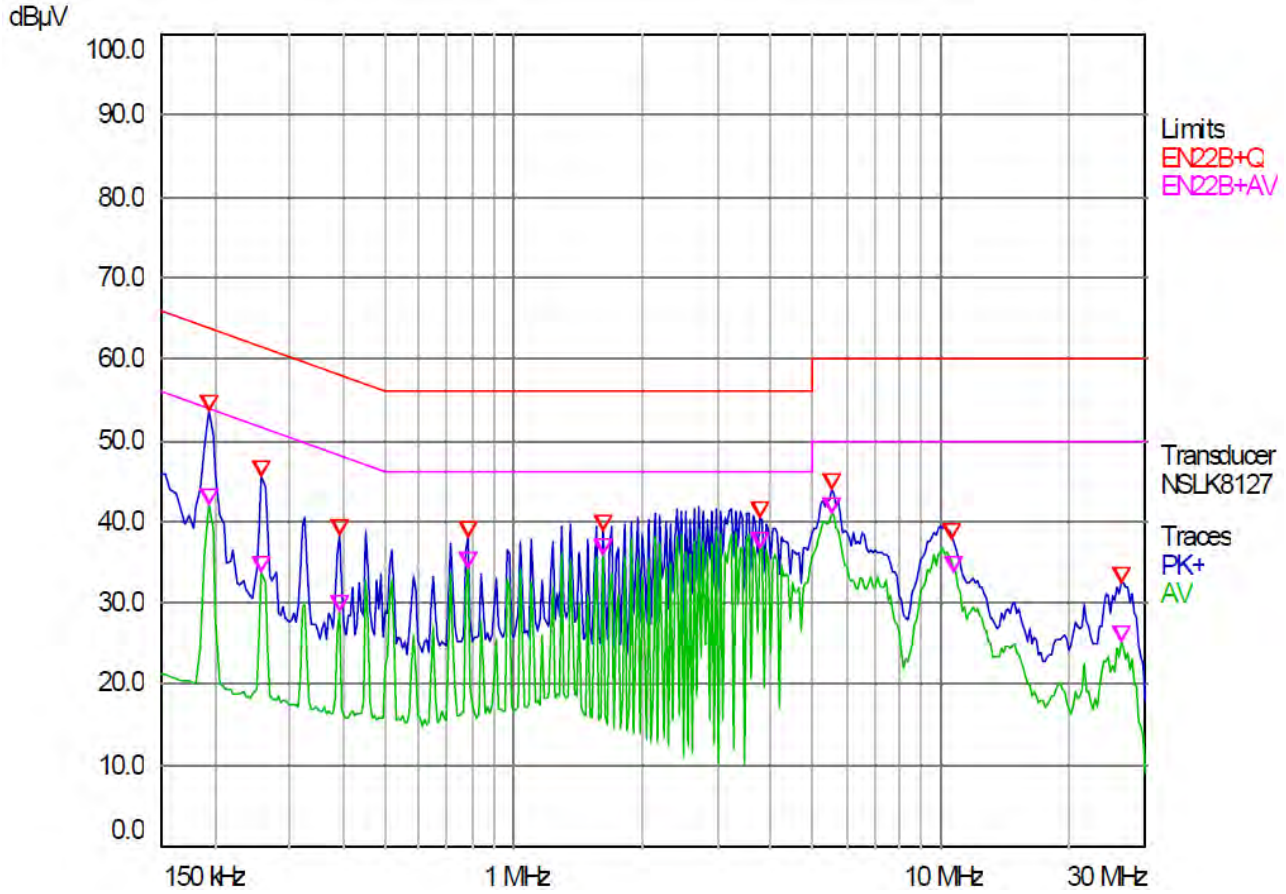
Plots of Conducted Emission Test



Test Model: M1503
Test Mode: NEUTRAL(PC Connection TX Mode)
Classification: FCC Part15 Subpart B Section 15.207(a) Class B

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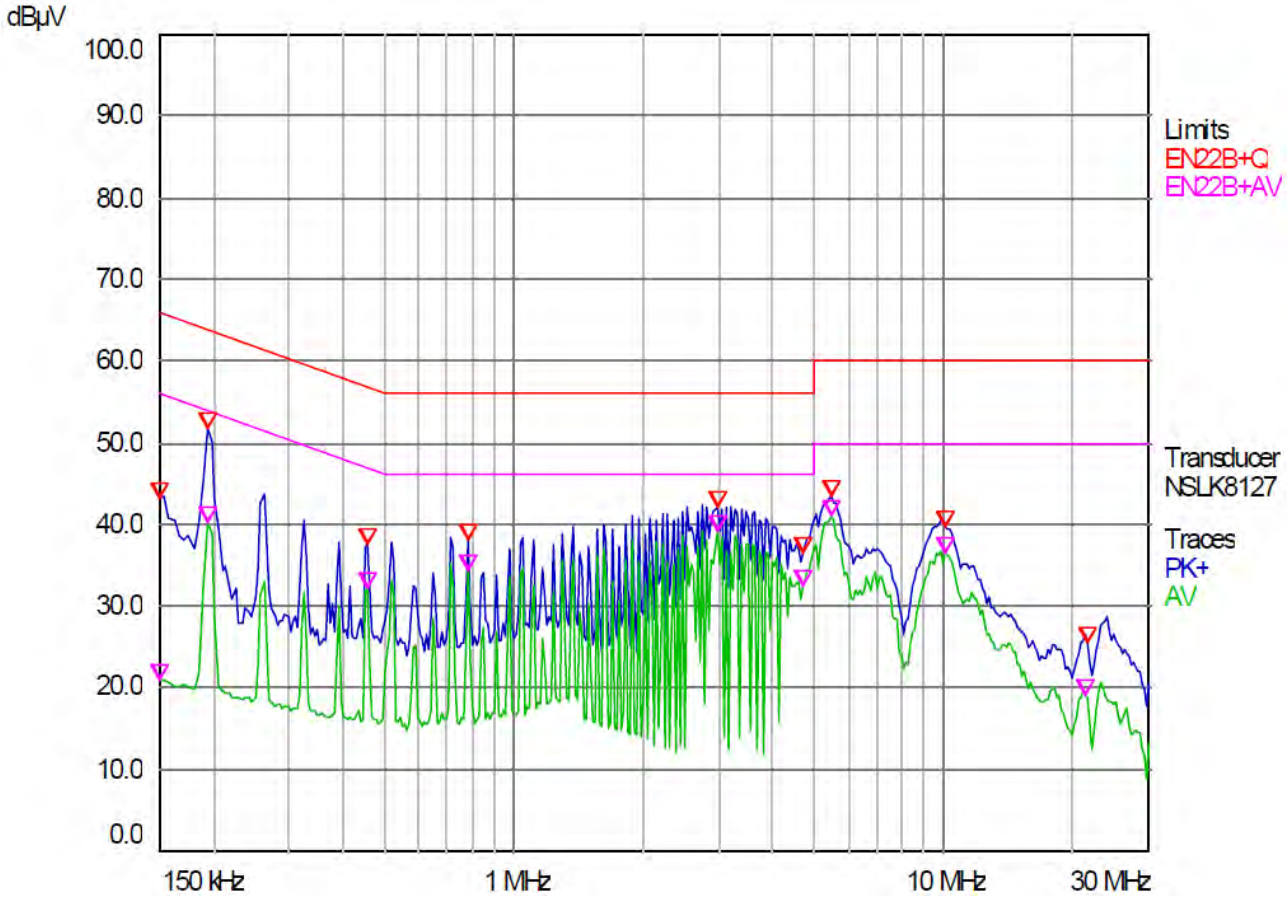
Plots of Conducted Emission Test



Test Model: M1503
Test Mode: HOT(PC Connection RX Mode)
Classification: FCC Part15 Subpart B Section 15.207(a) Class B

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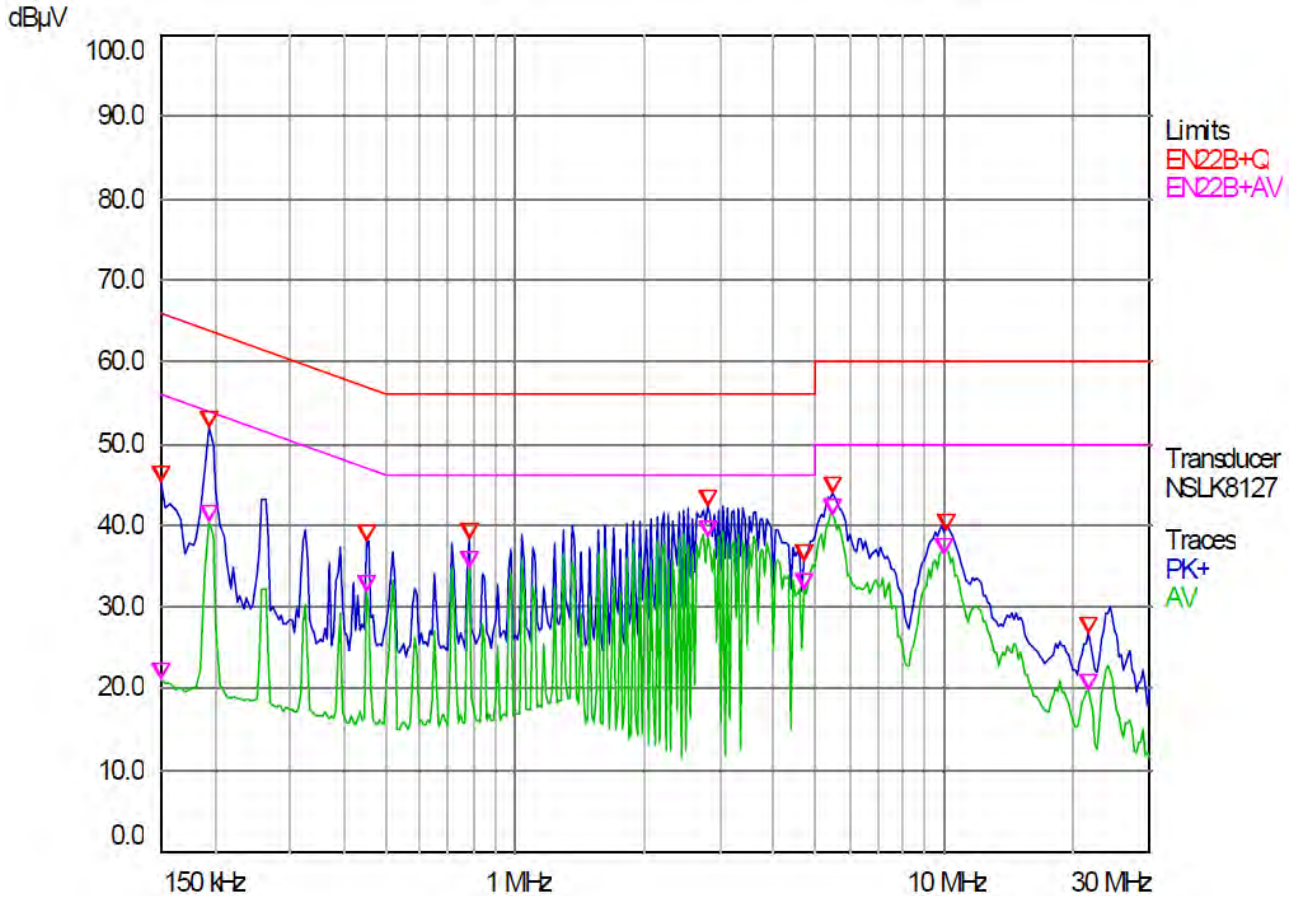
Plots of Conducted Emission Test



Test Model: M1503
Test Mode: NEUTRAL(PC Connection RX Mode)
Classification: FCC Part15 Subpart B Section 15.207(a) Class B

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5.9 Emission Mask & Modulation characteristic

EUT	ReFlex Telemetry Device / M1503
Test Date	June 21, 2011
Operating Condition	Continues TX
Environment Condition	26 °C/ 53 % R.H.
Result	Passed

5.9.1 Definition

The transmitter sideband spectrum denotes the sideband power produced at a discrete frequency separation from the carrier up to the test bandwidth due to all sources of unwanted noise within the transmitter in a modulated condition.

5.9.2 Specification

FCC Rules Part 2, Section 2.1047
FCC Rules Part 24, Section 24.133
FCC Rules Part 90, Section 90.210

5.9.3 Method of Measurement

ANSI/TIA-603-C-2004 Section 2.2.11

5.9.4 Measurement Set-Up

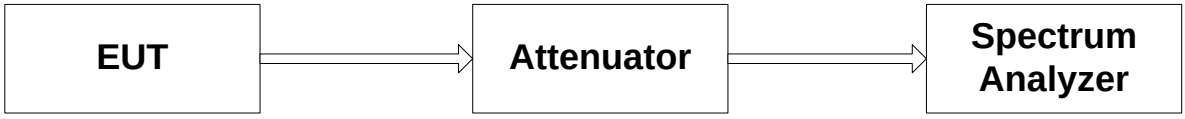

Fig-2

5.9.5 Test Equipment List

Equipment	Model Name	Manufacture
EUT	M1503	HUNETEC
Attenuator	SA18N25WA	FAIRVIEW MICROWAVE INC.
Spectrum Analyzer	FSP13	ROHDE & SCHWARZ

5.9.6 Test Procedure

① Connect the equipment as Fig-2.
② The test shall be performed using the modulation of the EUT.

5.9.7 Limit

① MASK J
② MASK K

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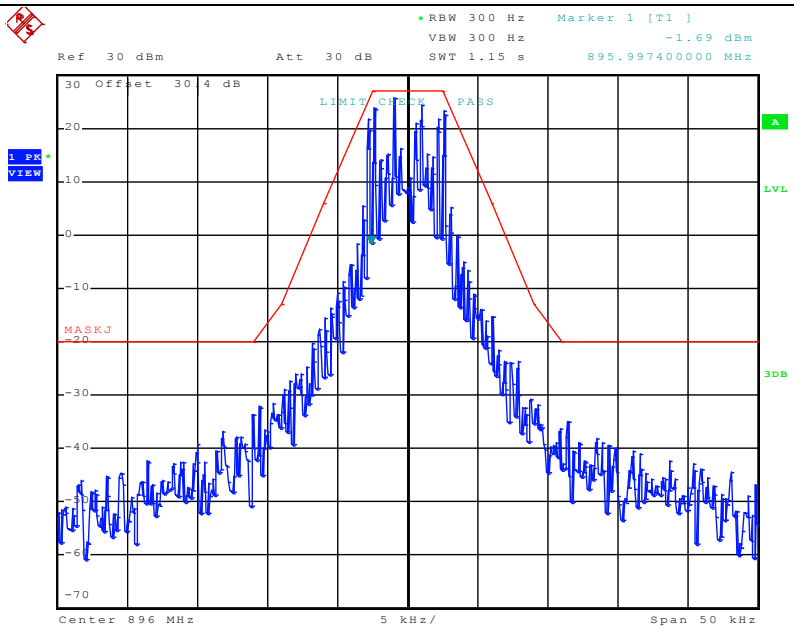
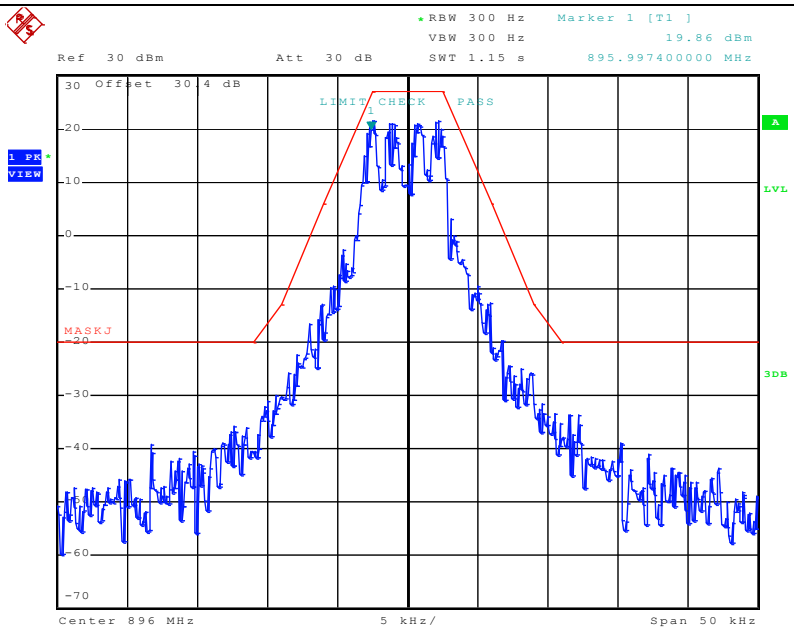
5.9.8 Plot of Emission Mask

Frequency	Emission Mask & Modulation characteristic
896 MHz Mask J Modulation 800	
896 MHz Mask J Modulation 1600	

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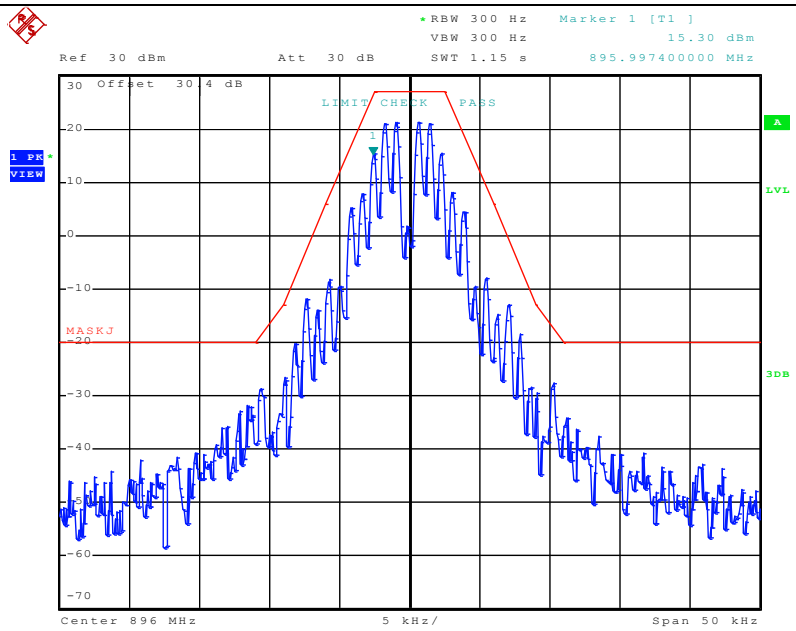
Frequency	Emission Mask & Modulation characteristic
896 MHz **Mask J** **Modulation 6400**	 Date: 25.JUN.2011 11:05:39

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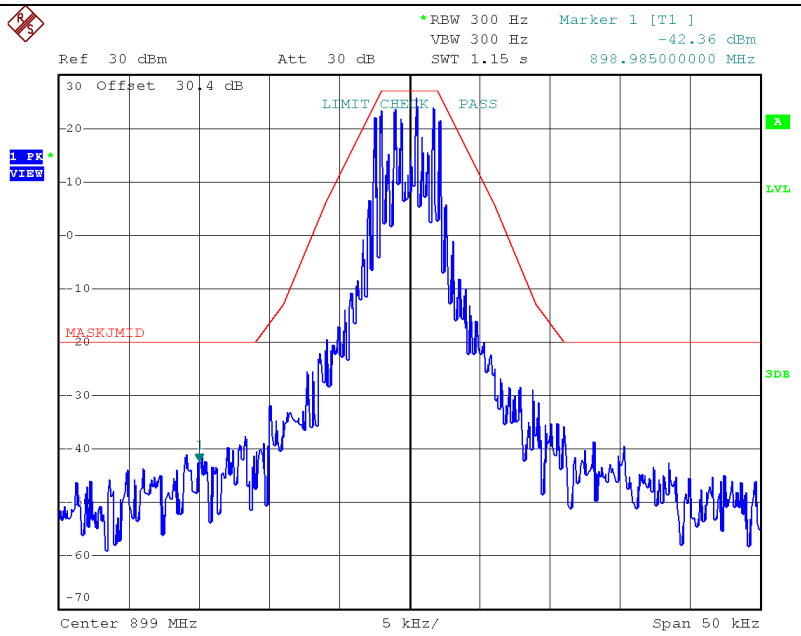
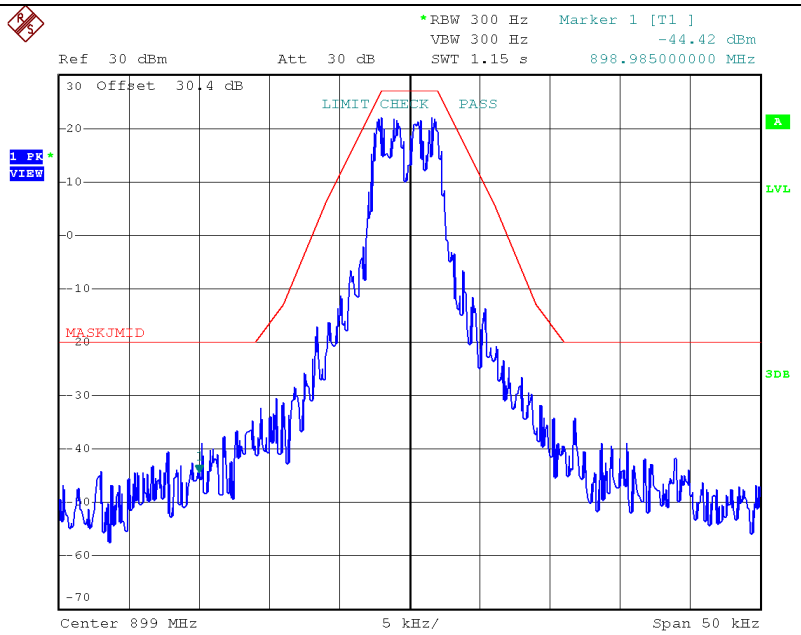
Frequency	Emission Mask & Modulation characteristic
899 MHz **Mask J** **Modulation 800**	 Date: 25.JUN.2011 11:02:09
899 MHz **Mask J** **Modulation 1600**	 Date: 25.JUN.2011 11:02:40

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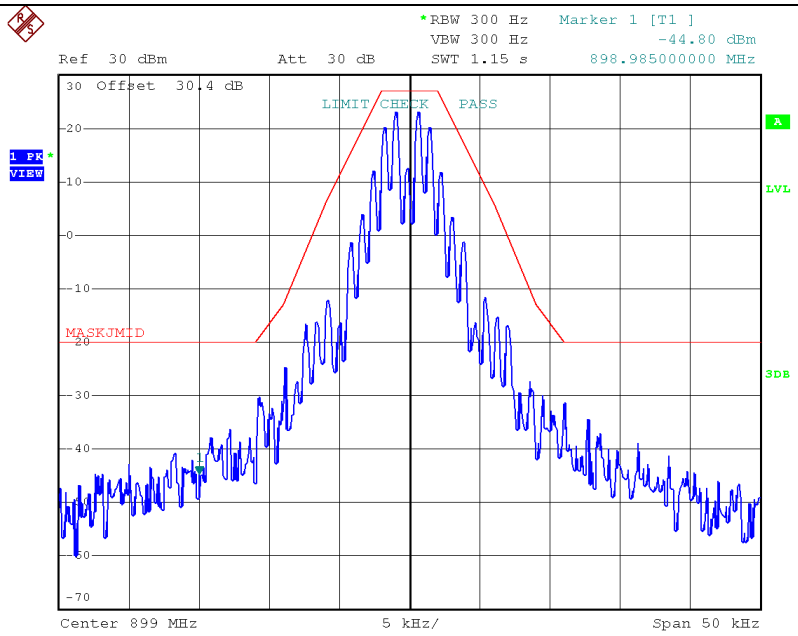
Frequency	Emission Mask & Modulation characteristic
899 MHz **Mask J** **Modulation** **6400**	

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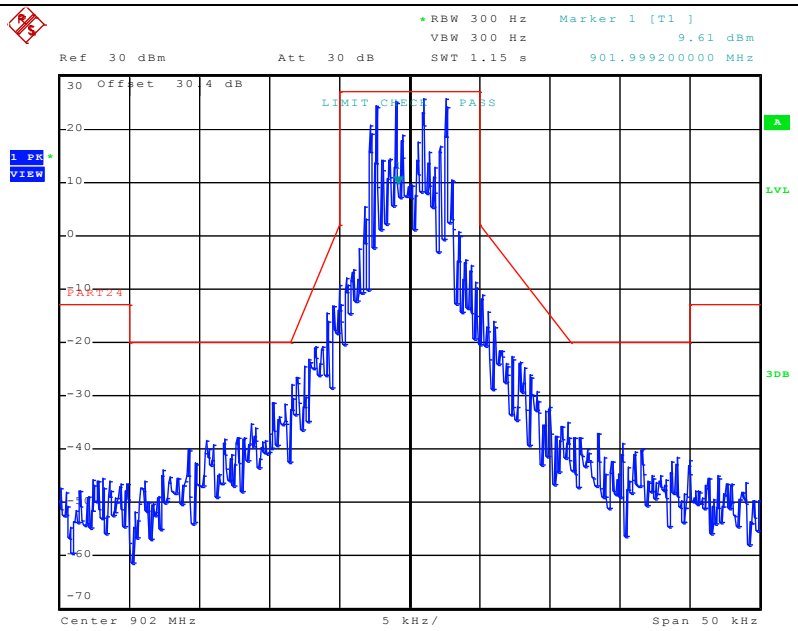
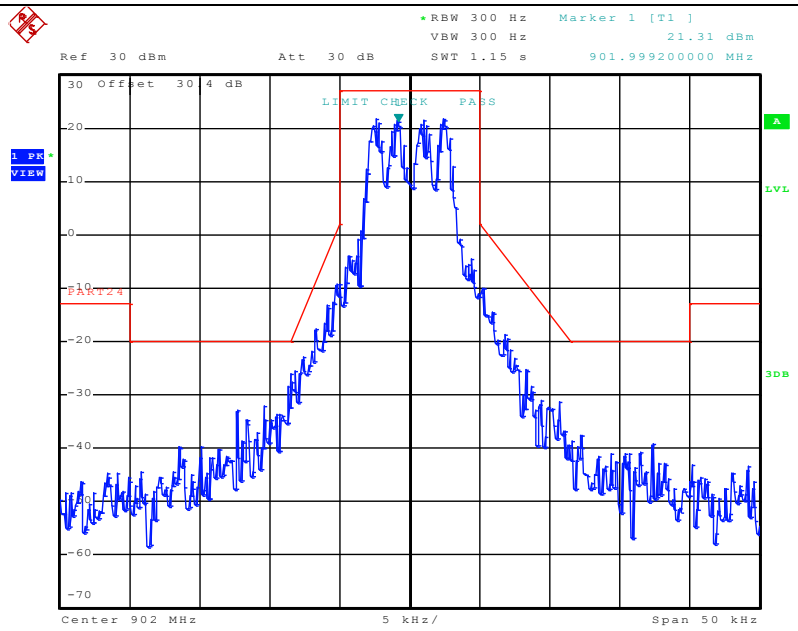
Frequency	Emission Mask & Modulation characteristic
902 MHz Mask K Modulation 800	 Date: 25.JUN.2011 11:00:06
902 MHz Mask K Modulation 1600	 Date: 25.JUN.2011 10:59:36

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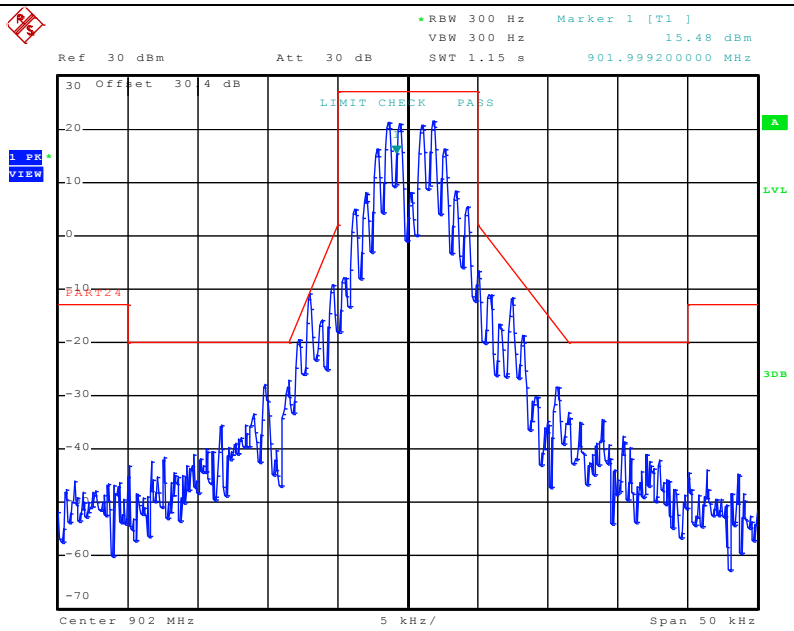
Frequency	Emission Mask & Modulation characteristic
902 MHz **Mask K** **Modulation 6400**	 Date: 25.JUN.2011 10:59:12

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7. List of test equipments used for measurements

The listing below denotes the test equipments utilized for the test(s).

EQUIPMENT		MODEL	MANUFACTURE	SERIAL NUMBER	Calibration Due date
1	Receiver	ESVN30	ROHDE & SCHWARZ	832854/010	2012/01/24
2	Receiver	ESPI	ROHDE & SCHWARZ	100012	2012/01/25
3	Spectrum analyzer	FSP13	ROHDE & SCHWARZ	100278	2012/07/01
4	Signal Generator	GT9000	GIGATRONICS	9604010	2011/10/15
5	Frequency Counter	R5372	ADVANTEST	41855204	2011/10/14
6	Shield Room (7m x 4m x 3m)	N/A	SJEMC	0004	N/A
7	Turn Table	OSC-30	N/A	BWS-01	N/A
8	Antenna Master	JAC-3	DAIL EMC	N/A	N/A
9	Antenna Turntable Controller	JAC-2	JAEMC	N/A	N/A
10	Temperature & Humidity chanber	SJ1013-TH	SEOJIN	N/A	2011/10/14
11	Bilog Antenna	VULB9161	SCHWARZBECK	VULB9161-4067	2011/12/01
12	Bilog Antenna	VULB9161	SCHWARZBECK	VULB9161-4068	2011/11/12
13	Horn Antenna	BBHA 9120 D	SCHWARZBECK	BBHA 9120 D 517	2012/10/14
14	Horn Antenna	BBHA 9120 D	SCHWARZBECK	BBHA 9120 D 474	2012/07/14
15	Power Meter	E4418A	HP	GB38272621	2011/10/14
16	Power Sensor	E9301B	HP	US40010238	2011/10/14
17	Power supply	IPS-30B03DD	INTERACT	42052	2011/10/15
18	Bilog Antenna	VULB 9161	SCHWARZBECK	9160-3052	2013/06/29
19	Open Site Cable	SUCOTEST 18A	Hubersuhner	8400/18A	N/A
20	Chamber Cable	SUCOFLEX 104	Hubersuhner	317392/4	N/A
21	Chamber Cable	SUCOFLEX 104	Hubersuhner	323837/4	N/A
22	Antenna Master	N/A	AUDIX	N/A	N/A
23	Antenna Turntable Controller	JAC-2	JAEMC	N/A	N/A

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